



Full Resolution Geoid from GOCE Gradients for Ocean Modelling

Herceg, Matija; Knudsen, Per

Publication date:
2009

Document Version
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

Citation (APA):
Herceg, M., & Knudsen, P. (2009). *Full Resolution Geoid from GOCE Gradients for Ocean Modelling*. Poster session presented at 2009 AGU Fall Meeting, San Fransisco, CA, United States.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Full Resolution Geoid from GOCE Gradients for Ocean Modeling

Matija Herceg¹, Per Knudsen¹

¹Department of Geodesy, DTU Space, Copenhagen, Denmark

Poster number: G43B-0744

Introduction

The main objective of the study is to improve the methodology for combining GOCE gravity field models with satellite altimetry to derive optimal dynamic ocean topography models for oceanography. Here a method for full resolution geoid determination using simulated GOCE gradients is presented.

Background

Preliminary results by Knudsen and Tscherning have indicated that compared to a spherical harmonic expansion truncated at degree 200 a full resolution determination of the geoid may reduce the omission error from about 30 cm to 15 cm. Combining GOCE geoid models with satellite altimetric observations of the sea surface height might lead to substantial improvements in the modeling of the ocean transport and circulation.

The primary requirement for oceanographers is to have access to a geoid and its error covariance at the highest spatial resolution and accuracy possible. For that purpose a point mass program is developed for processing GOCE gradients in order to determine the geoid.

Point mass method

The masses for each point are calculated using the first order derivatives of gravitational potential (from GOCINA gravity anomaly values, EGM96 to degree 200 has been subtracted to obtain residual gravity anomaly values). Then the Earth anomalous gravity field is modelled by the set of base functions, each obtained as the anomalous gravity potential from each point masses. From the anomalous gravity field, the geoid is then calculated using Bruns formula. Gradients are then computed using second order derivatives of the gravity potential.

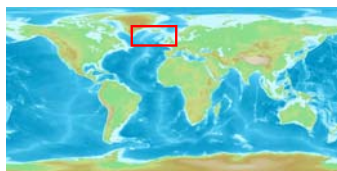


Fig. 1. GOCINA region

Evaluation of the geoid is carried out in the part of the GOCINA region in the North Atlantic (figure 1).

For evaluation of the calculated geoids, Gravsoft Geofour is used as a reference. Geofour program is used for gravity field modeling using fast Fourier transform.

Gradients (used as simulated GOCE gradients) are processed in point mass program to obtain the geoid. From that, geoid determination using point mass and GOCE gradients is demonstrated.

The unknown masses may be estimated by inverting gravity data. First step in the calculation of the geoid using point masses is to create a grid of GOCE data at the satellite altitude. This grid is used to calculate point masses at the same grid points but 270km below. Two steps are then following; one for calculation of gravity gradient and another for calculation of geoid.

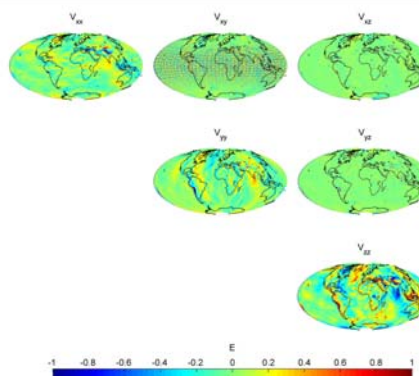


Fig. 2. GOCE tensor elements

Results

Using GOCINA gravity anomaly (figure 3) both Gravsoft (figure 5) and point mass geoid (figure 6) are calculated. Residuals are presented on figure 7. Vertical gradient from simulated GOCE gradient in GOCINA region can be seen on figure 4.

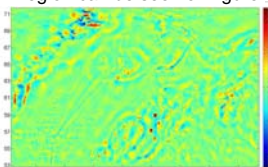


Fig. 3. GOCINA gravity anomaly

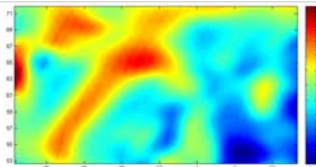


Fig. 4. V_{zz} tensor component over GOCINA region

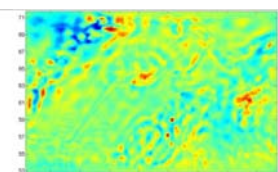


Fig. 5. Geoid from Gravsoft

Min	Max	Mean	Stn. Dev.
-2.36m	2.34m	0.00m	0.38

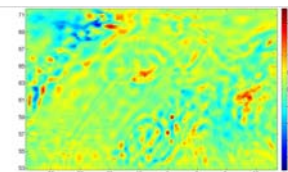


Fig. 6. Geoid from Pointmass

Min	Max	Mean	Stn. Dev.
-1.94m	2.31m	0.09m	0.36

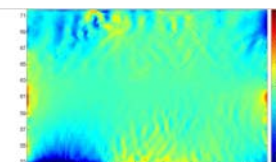


Fig. 7. Difference between Gravsoft and point mass geoid

From these figures it is visible that the differences between point mass method and Gravsoft GEOFOUR are very small – only few centimeters across the grid. The big differences can be seen mostly on the edges; these differences are most likely result of periodicity of the fast Fourier transform used in the GEOFOUR Gravsoft program.

Conclusions

Applying this method on GOCE gradient data, it is possible to make independent validation of already accepted methods for geoid determination. The presented point mass method shows that it is possible to acquire a full resolution geoid from GOCE gradients. Results of the method can be used in future geoid modeling. New detailed geoid surface will serve as a homogeneous and accurate reference surface for satellite altimetry and in that way it will provide important improvements in the ocean circulation modeling.

References

- W.M. Telford, L.P. Geldart, R.E. Sheriff, D.A. Keys: Applied geophysics, 1985
- C. Antunes, R. Pail, J. Catalão: Point mass method applied to the regional gravimetric determination of the geoid, 2003
- R. Forsberg, C.C. Tscherning: GRAVSOFT, Geodetic Gravity Field Modelling Programs (overview manual), 2008
- P. Knudsen and The GOCINA team: Integration of Altimetry and GOCE geoid for Ocean Modeling